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AUTHOR Schwendau, Mark
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ABSTRACT

Indian Valley Vocational Center (IVVC) has implemented the first vocational computer-aided design (CAD) program in the state of Illinois. The CADAPPLE turnkey system is used by students to do drafting problems assigned from their self-paced workbook "CAD-Tutor." A buddy system allows for students to alternate weeks as operators and observers. The CADAPPLE system provides eight primitives (geometric objects) that can be combined into more complex groups, supports five different input modes, and maintains coordinate data to an accuracy of over six digits. Since IVVC's primary objective is to provide entry-level job training, offering CAD instruction is justified. While critics of the CADAPPLE turnkey CAD system have dubbed it a toy because it runs off of an Apple computer, others have said that it provides an inexpensive way of training CAD operators who receive more advanced training on the job. Constant updating of the software shows improvement based on user input. (YLB)

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VOCATIONAL "CAD" EDUCATION
at the
Indian Valley Vocational Center
Sandwich, Illinois

by
Mark Schwendau
c. 1983

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Background

Indian Valley Vocational Center (IVVC) Sandwich, Illinois began teaching vocational drafting to high school juniors and seniors nine years ago this fall. IVVC drafting students never had to fiddle with antique drafting equipment such as T-squares, angles, and protractors--instead, they were equipped with the most up-to-date equipment of the day. That equipment included modern track type drafting machines, pedestal drafting tables, and a variety of templates. While that equipment was modern yesterday, it is rapidly becoming outdated today. Thanks to a progressive advisory council and school board, IVVC has moved into the 21st century with the implementation of the first vocational computer-aided design (CAD) program in the state of Illinois.[1]

For those who are new to computer-aided design, CAD involves the creation of graphic designs on a video display screen by computers and other electromechanical devices. The designs may be printed or plotted to hard copy or stored to disk to form a data base. CAD is to the drafter as word processing is to people that work with words. Because a picture is worth a thousand words, and the computers that create these graphic pictures must do much more than the average word processor, CAD systems usually cost thousands of dollars more than the average word processor.

The IVVC Drafting and Design Advisory Council researched the CAD

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market for three years before deciding to purchase the Apple based CADAPPLE software of T & W Systems. The council liked the information that T & W Systems provided. Even better was the total turnkey system price of less than $12,000. In computer-aided design a turnkey system is a system that is considered to be a complete, ready to use, system as it is sold. The companies that market these systems usually provide operator training as part of the system price.

Program Overview

IVVC students use thier CADAPPLE turnkey system to do drafting problems assigned by their instructor from their workbook CAD-Tutor, a self-paced workbook that contains both study questions and drawing problems. The software is contained on four diskettes. The software is written in UCSD Pascal computer language, however, students need not know sophisticated computer programming as all commands and command prompts appear in English. Drafting function commands are selected by the student with single keystrokes from a menu. Students in the IVVC program are stationed at the system for one week as an observer doing written assignments and assisting the operator. The second week the student serves as the actual operator. IVVC students have found this "buddy system" works best for them. They are usually pretty well adjusted to the system by the time they take the operator's seat. The students rotate taking turns through the entire school year. Naturally, the larger the class is the less computer time each student gets.[2]

System Overview

Eight primitives (geometric objects) are provided by the CADAPPLE system. These primitives can be combined into more complex groups that give the designer drawing speed. The primitives are lines, arcs, circles, rectangles, ellipses, regular polygons, Bezier curves, and text. For example: using the system, a road stop sign can be created with two primitive commands, polygon and text, and saved as a group named "Stop Sign". Groups can be further modified. They can be moved, copied, rotated, as the designer desires. Besides primitives, the system also supports automatic dimensioning where the full scale numeric value of a distance is calculated by the computer. The computer prompts for the desired distance to be dimensioned, the distance the dimension is to be placed from the view, and the location of the dimension's text.

The system supports five different input modes including the Houston Instruments DT-11 Digitizer, Apple Joystick, and keyboard entry of coordinates using absolute, relative, and polar modes. Grids are maintained on the viewing screen according to specifications established by the operator. The grids are divisible by the operator as well. A coordinate dial can be used to continuously report the real world coordinate position of the graphic input device. The dial provides a readout to ten thousandths of an inch. The system maintains coordinate data to an accuracy of over six digits. Objects as large as 100.0625 inches have been accurately created on CADAPPLE. Floppy disk CADAPPLE systems, such as the IVVC system, have been used to store

1,600 primitives in one drawing.[3]

System Configuration

The IVVC system uses two floppy disk drives with two disks loaded at all times. The CADAPPLE "Boot" disk contains most of the drafting commands for the computer. The "Work" disk is used as a temporary workfile for day today work. The "Help" disk is a summary of the CADAPPLE reference manual and is swapped with the Boot disk when the operator needs quick help with a particular drafting function command. The "System" disk is used to accomplish standard Pascal file management functions.

CADAPPLE software comes with two printed circuit boards or cards, besides the four diskettes, that are plugged into the Apple's ports. The CADAPPLE card is a custom-made card by T & W Systems that allows the Apple to do drafting functions. The "Mill" card is a Pascal speed-up card that makes the Apple run faster.

The first station IVVC purchased consisted of hardware of an Apple II+ for information processing unit, two Apple Disk II drives (one with controller) for memory recording, one 12" Zenith CRT for graphic display, one 9" Sanyo CRT for menu display (with Videx card), a TG Joystick for an input device, and a Houston Instruments' DMP 7/8 flatbed plotter for hard copy output. A Hewlett Packard 7225B plotter was later donated to the program by our local Apple dealer.[4]

The system supports both Houston Instruments and Hewlett Packard plotters that can draw up to 24" x 36", or what most drafters refer to

as a "D" size drawing. The system permits the operator to have complete control over his destiny even in the output menu. Operators can create and save user definable plot specs that control the relationship between what is seen on the CRT screen and what is plotted as hard copy. Printers may also be used to make a quick low quality hard copy.[5]

Due to the student's request for more computer time on a class evaluation form, a second station is planned for this school year. The second station will consist of the Apple IIe for an information processing unit, a Vitamill card used for Pascal speed-up (in place of the Mill), and the Houston Instruments' DT-11 Digitizer (graphics tablet) for an input device. All other hardware will be the same as used with the first system. This second station will be similar to those CADAPPLE turnkey systems adopted by industries. The systems used by commercial industries use an Axlon Ramdisk and Accelerator speed-up card. This gives them increased speed and drawing storage space. This version of the CADAPPLE makes for an affordable alternative to many other CAD systems now on the market.

Justification

The primary objective of IVVC is to provide entry level job training. Considering that almost all different types of industry will have adopted CAD over drafting tables by the year 2000, we feel we would be foolish not to be offering CAD instruction now. A person on a CAD system is considered to be four to eight times as efficient as a

person at a drafting table with a drafting machine. Specific benefits are listed below.

1. CAD is unquestionably a faster method of creating drawings.
2. Once data is loaded into the data base, modifications are made more quickly and easily increasing productivity by as much 100 times.
3. CAD systems give designers more time to experiment with new designs that might otherwise have gone untested.
4. CAD, with 3-D enhancement, eliminates the need for costly and time consuming model building.
5. CAD eliminates the drudgery of the drawing process.
6. CAD offers control and flexibility in drawing creation, that never existed before, through combinations of layering and nesting of drawing views or individual elements.[6]

These are just a sample of the more popular reasons a company opts for a CAD system over the traditional manual approach to drafting and design. Industry has little reason to maintain old practices. IVVC students trained on CADAPPLE are adaptable to many different applicatons of T & W Systems including the IBM-PC VersaCad system, the Mars-CAD system of Staedtler Mars, and the Hewlett Packard 2-D Based Drafting system. In addition, T & W Systems are similar in command structure and operation to both the IBM CADAM and Unigraph CAD systems.

Critics of the CADAPPLE turnkey CAD system have wrongfully dubbed it a "toy", presumably because it runs off of an Apple computer. A recent issue of Machine Design magazine reported, "These new (inexpensive) systems are not toys but are designed mainly as entry-level systems for firms that cannot justify large sums (of money) for CAD. They also provide an inexpensive way of training CAD

operators.[7] The National Computer Graphics Associaton (NCGA) has filed a report that predicted a need for over 100,000 additional CAD operators by the year 1985. That same report indicated that the prohibitive costs of offering CAD training on some of the larger systems was not cost effective as only a fraction of the full potential of the system is realized in training. Most advanced CAD experiences occur on the job. Also, the number of students served by the larger systems in training centers is severely restricted. The NCGA report stated that it costs about $10,000 and 120 hours of training during a period of six weeks to acquire 80 percent of normal CAD skills. The report suggests a viable alternative is to offer CAD training on low cost CAD systems that could save industry half a billion dollars in training costs in just four years. Industries have heard the message of this report.

CADAPPLEs have now been installed in New Zealand, Singapore, Japan, the Phillipines, Sweden, Monaco, Germany, Kenya, Israel, Holland, Italy, Belgium, and Portugal.[8] American companies that are using CADAPPLEs include Morrill Electric, General Motors, TRW, the US Geological Survey, and Westinghouse to name but a few. The list continues to grow. Community colleges in California, Florida, New York, Massachusetts, Missouri, Tennessee, Iowa, Ohio, Michigan, Oregon, and Texas now use CADAPPLEs. There are now CADAPPLEs being used in schools in over half the states of these United States.[9] Illinois' educational institutes that use CADAPPLEs, besides IVVC, include the University of Illinois, Southern Illinois University, and the Bloomington Area Vocational Center.

T & W Systems' secret to success has been constant updating of their already excellent software products while others have remained stagnant. We have had our system now for 15 months and we are currently in our fourth revision of CADAPPLE software. Each new version is improved by T & W Systems with input from their users on what they desire in the software they are using. The Anderson Report, an independent CAD review newsletter, gave CADAPPLE systems an excellent review saying, "Maybe CADAPPLE is the VisaCalc of the CAD business."[10] Those that are familiar with VisaCalc know that this was a very high compliment to T & W Systems.

Conclusion

I have seen drafting instructors from all over this nation react to CAD. Those who have reservations fall into two main categories: those instructors who are afraid of something this revolutionary and fear the age old man versus machine dilemma, and those who want to remain progressive very badly but are afraid of either their administration's or board's reaction to a request for a $12,000 CAD system and not being able to justify the expenditure in either the board's or the administration's presence.

Those instructors that fall into the first category of the fear of the man versus machine dilemma can easily be understood. Consider this--computer-aided design in the 21st century may use voice input over the traditional forms of input we are now using. If that sounds far out, how about the eye tracking device being considered right now.

This device would involve a low-level laser beam being reflected from the retina of the operator's eye. Eye movements could control menu displays and other common CAD functions such as symbol manipulation and positioning of drawing primitives. A body movement detection system is also being considered as a possible alternative to today's input methods. With this, system body language could be translated into the graphic language. Watch dotting those eyes! A cognitive interface is being studied by the Hewlett Packard company already. This device would involve attaching instrumented sensors to the operator's scalp.[11] This system reminds me of the Clint Eastwood movie "Firefox". Reality is following close on the tail of Hollywood. Hewlett Packard just recently announced a new computer that responds to the touch of a person's finger on its CRT screen. I would say the fears of those instructors in this first category are understandable and I share some of them.

People that fall into the second group of drafting instructors, the fear of failing to justify a CAD system to their superiors, will have a much easier time than I did. There is a wealth of documentation now available on the justification of CAD systems, a small portion of which I have provided myself. Several college studies are currently under way to establish just how much faster computer-aided design is over manual drafting. These studies will give us concrete evidence of the cost effectiveness of CAD. It is my sincere hope that this paper with some of the other writings listed in the Bibliography of this paper, together with results of research being conducted now, will give drafting instructors the courage to approach their superiors and

request the drafting tools that will be commonplace in the very near future.[12] As I see it, if our superiors in education fail to accept computer-aided design CAD today, they may also be saying that there will be no need to teach drafting in our schools tomorrow. They could not be more wrong!

In the workforce today, it is estimated that 45 to 55 percent of the people working are in the information processing business. By the year 2000 that figure is expected to rise to 80 percent. It is also said that three out of four jobs in the 1980's will require technical training below the baccalaureate level of education. This is according to a study conducted by the Bureau of Labor Statistics as reported in the paper "The Shortage of Skilled Workers" submitted to the American Vocational Association AVA.[13] According to conservative estimates, between 10,000 to 13,000 new CAD systems will be installed next year 1984. If we of the Illinois Technical Drafting Teachers Association (ITDTA) will not assume the responsibility of training the new operators of these systems, just who will?

IVVC will probably continue to teach drafting basics at the drafting table with machine. As we see it, students of drafting have to learn how to walk in manual drafting before they can run with a CAD system. The future of the IVVC Drafting and Design Program holds both 3-D enhancement capabilities by the fall of 1984 and computer-aided manufacturing (CAM) by the end of 1985. We are very excited to be riding the crest of this high technology wave and we will be happy to share our excitement in the form of teacher in-service workshops and mini-training sessions in the future.

If you would like more information on the IVVC CADAPPLE turnkey CAD system, write to me: Mark Schwendau, IVVC, 600 Lions Road, Sandwich, Illinois 60548-2499. The ERIC Clearinghouse for educational information has asked me to submit a copy of this paper for their files and I intend to meet their request. If you would like a copy of this paper after today, please contact ERIC. Thank you.

Footnotes

[1]Keenan, C., "CAD System Grooms Drafters for Employment". Plan and Print. Franklin Park, IL, International Reprographic Association, May 1983, pp. 20, 21, and 47.

[2]Schwendau, M.S., "Vocational "CAD" Education". Illinois Industrial Educator. DeKalb, IL, Illinois Industrial Education Association, Winter 1983, (Page unknown as of date this paper was given).

[3]Beauchemin, R., R. Krimper, J. Manifor, J. Sunyogh, "Introduction". CAD-Tutor. Los Angeles, CA, CAD Ventures Unlimited, 1983, pp. 1-5.

[4]Schwendau, M.S., "Purchasing a CAD System". School Shop. Ann Arbor, MI, Praken Publications, February 1983, pp. 22 and 24.

[5]Voisinet, D.D., "Manufacturer's Equipment". Introduction to CAD. New York, NY, Gregg Division/McGraw Hill, 1983, p. 205.

[6]Gunn, T., "Computer-aided Design". Computer Applications in Manufacturing. New York, NY, Industrial Press, 1981, pp. 152-154.

[7]Teschler, L., "Low-Cost Drafting on Personal Computers". Machine Design. Cleveland, OH, Penton/IPC, August 25, 1983, pp. 65-69.

[8]Lazear, T., "International Users". T & W Systems Newsletter. Huntington Beach, CA, September 1983, p. 1.

[9]Lazear, T., "CADAPPLE Users". T & W Systems Newsletter. Huntington Beach, CA, May 1983, p. 1.

[10]Anderson, B. J., "Inside Report", The Anderson Report. Simi Valley, CA, Anderson Publishing Co., April 1982.

[11]Krouse, J. K., "Computer-Aided Design in the 21st Century". Machine Design. Cleveland, OH, Penton/IPC, March 10, 1983, pp. 214-220.

[12]Schwendau, M.S., "No" (Debate Column). NEA Today. Washington, D.C., NEA Publications, December 1983 (Page unknown as of date this paper was given).

[13]Langer, V., "Computer-Aided Design". Preparing Students for High Technology Careers. Washington, D.C., American Vocational Association Publications, 1983, pp. 3 and 4.

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ABOUT MARK SCHWENDAU

Mark Schwendau has been the vocational drafting and d sign instructor at Indian Valley Vocational Center, Sandwich, Illinois, for the past six years. He has taught evening classes in drafting for several community colleges. He has a hobby of writing and has written many magazine articles on the subject of drafting and design. He has also co-authored a drafting text that is scheduled for release in the next year.

Mark's students regularly win both national and state drafting contests. His junior and senior high school age students were the first to be offered instruction in computer-aided design (CAD), in the state of Illinois, at such a young age.

Mark defines his job as the recruitment, training, evaluation, and placement of young people in drafting or drafting related positions. For 1982 the IVVC Drafting and Design program had a placement of 100%. Most of those students were in drafting related jobs or post high school education programs.